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INVENTORY & CATALOGING

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STATE OF ALASKA
Bill Sheffield, Governor

Annual Performance Report for

INVENTORY OF HIGH QUALITY RECREATIONAL FISHING WATERS IN SOUTHEAST ALASKA

By

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Volume 25 Study No. G-I-R

RESEARCH PROJECT COMPLETION REPORT

State: Alaska Name: Sport Fish Investigations of Alaska

Project: F-9-16

Study No.: G-I Study Title: INVENTORY & CATALOGING

Job No.: G-I-R Job Title: Inventory of High Quality Recreational Fishing Waters in Southeast Alaska

Cooperator: Artwin E. Schmidt

Period Covered: July 1, 1975 to June 30, 1984

ABSTRACT

Limnological relationships and recreational analyses were conducted on 44 lakes in southeast Alaska in an attempt to 1) determine the relationship of physical, chemical, and biological characteristics of these lakes to fish production and 2) protect high-quality fishing and recreational areas from undesirable development.

The morphoedaphic index (MEI) (Ryder, 1964; 1965) was used to establish a ranking of productivity and estimate potential fish yield for each system studied. Lakes in southeast Alaska are compared with other Alaskan systems and with lakes throughout the north-temperate region. The most productive lakes examined during this study were Mountain (MEI = 2.88) and Situk (MEI = 2.20). All other lakes had a MEI of less than 2.0, indicating very unproductive water.

KEY WORDS

Southeast Alaska, limnology, productivity, quality watersheds, fish populations, recreation analysis.

BACKGROUND

The inventory and cataloging program in southeast Alaska realized a need for more comprehensive limnological and fishery investigations in 1972. At that time, the Inventory and Cataloging study was organized under one project leader who supervised the investigations throughout southeast Alaska.

This led to a more uniform method of data collection throughout Region I and better comparability of data, especially in the field of creel census. Another important contribution of this reorganization was the development of a filing system designed to facilitate the orderly acquisition and subsequent recall of information collected on lakes, streams, and saltwater bays in southeast Alaska. This filing system, developed in 1972, has been maintained through the present. Another computerized water file should now be established.

Lake and stream investigations conducted during the first years of the reorganized study were survey-type investigations designed to evaluate sport fishing potential of large areas for development or management potential. These surveys were often superficial and consisted of a one-time sampling or netting of a system. Examples of this type of survey were the "St. James Bay to Haines" resource evaluation, the "West Chichagof-Yakobi" sport fish potential evaluation, and the "Recreation Inventory of the Prince of Wales Island Road System." Although the need for this type of survey continued to exist, the need for a better understanding of productivity of southeast Alaska waters became apparent.

Comprehensive limnological analyses of lake systems began during 1974 when eight lakes were studied in detail.

The following research recommendations appeared in the 1973 and 1974 annual reports.

1. Effort should be made to conduct more comprehensive limnological investigations to determine the relationships of physical, chemical, and biological characteristics of selected lakes to fish production. Numerous investigators, including Hayes (1964), Northcote and Larkin (1956), Ball (1948), Carlander (1955), Turner (1960), Moyle (1956), and others, have shown the importance of understanding these relationships. The importance of quantifying food availability and food habits of various species of fish cannot be overemphasized.

2. Identify and protect from undesirable development high-quality recreational fishing waters in southeast Alaska.

Table 1 lists the common name, scientific name, and abbreviation of each fish mentioned in this report. Figure 1 shows the locations of the major study areas which were evaluated during the years this study was active.

RECOMMENDATIONS

1. The limnological characteristics and biological productivity of lakes analyzed under this job should be compared with other North American lakes in a publication suitable for an appropriate journal, i.e., Limnology and Oceanography.

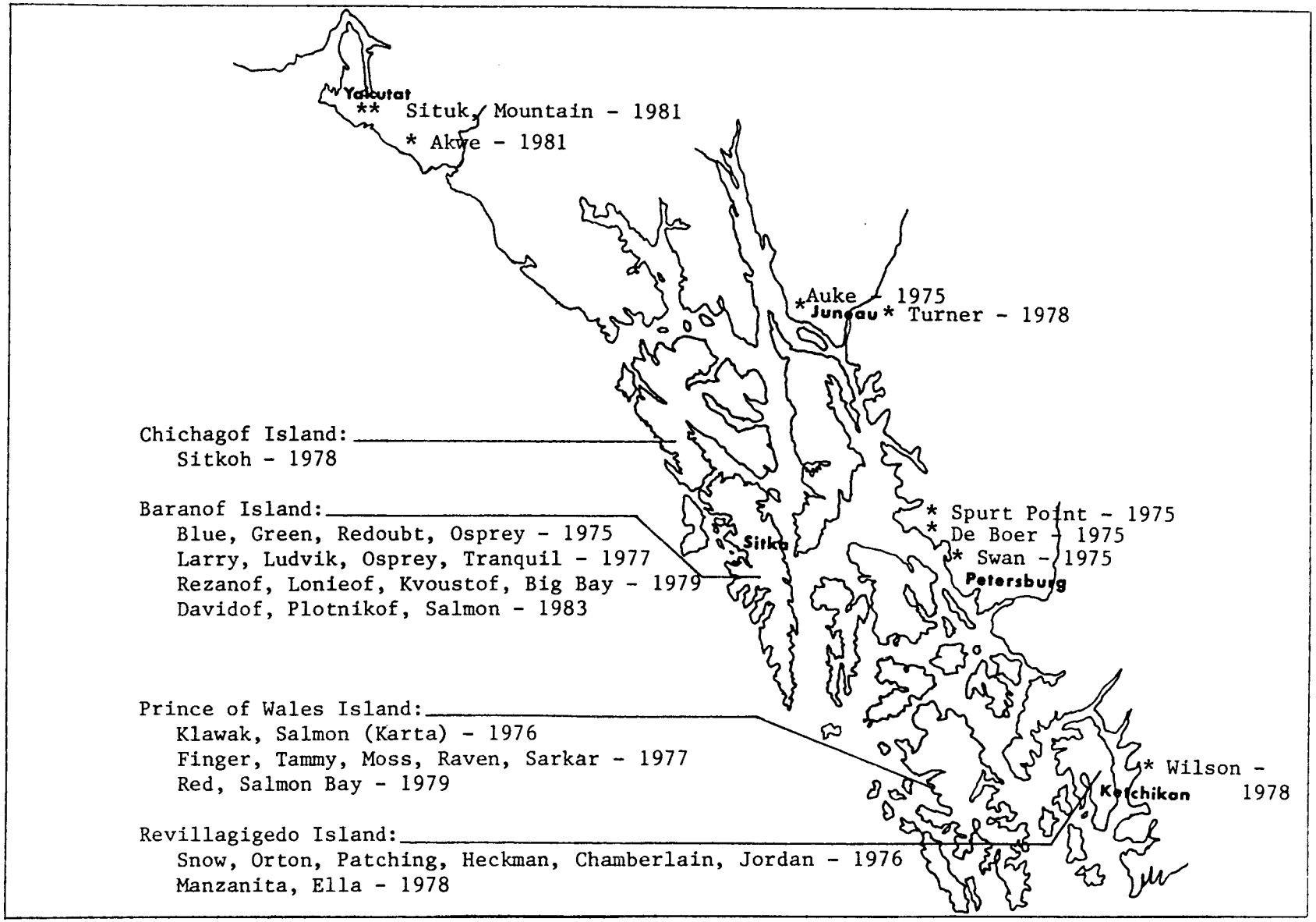

Fig. 1. Location and Year Surveyed for 44 Lakes Examined, Southeast Alaska, 1975-1984.

2. Fish population numbers and age/growth of these populations which have been evaluated during the course of this job should be compared in relation to the biological productivity index developed from recommendation 1.

OBJECTIVE

1. To write a Completion Report covering all of the previous years' work accomplished under this project.

Table 1. List of Common Names, Scientific Names, and Abbreviations.

Common Name	Scientific Name and Author	Abbreviation
Dolly Varden char	Salvelinus malma (Walbaum)	DV
Rainbow trout	Salmo gairdneri Richardson	RB
Cutthroat trout	Salmo clarki Richardson	CT
Sockeye salmon	Oncorhynchus nerka (Walbaum)	RS
Coho salmon	Oncorhynchus kisutch (Walbaum)	SS
Chum salmon	Oncorhynchus keta (Walbaum)	CS
Pink salmon	Oncorhynchus gorbuscha (Walbaum)	PS
Steelhead	Salmo gairdneri Richardson	RB
Kokanee	Oncorhynchus nerka (Walbaum)	KO
Threespine stickleback	Gasterosteus aculeatus (Linnaeus)	SB

2. Comprehensive limnological investigations should be conducted on the more productive lake systems so the relationship of physical, chemical, and biological indices can be related to fish production.

3. High quality recreational fishing waters in southeast Alaskashould be identified. Upon review of available information and research data, systems suitable for a type of classification should be submitted to the proper management agency for that classification.

4. The Sport Fish Division of the Alaska Department of Fish and Game (ADF&G) had attempted several times to obtain additional protection for high-quality fishing waters. In 1972, ADF&G made an official request to the forest supervisor of the Tongass National Forest to give special consideration to 18 identified high-quality watersheds.

5. As a result of the demonstrated need for more thorough investigations and a better understanding of the fisheries associated with the high-quality watersheds, the Inventory and Cataloging study was separated into three Jobs, including G-I-R; "Inventory and Cataloging of High Quality Fishing Waters in Southeast Alaska."

The objective of this study was to:

1. Determine the relationship of physical, chemical, and biological characteristics of selected lakes to fish production.

TECHNIQUES USED

Relationship of Limnological Characteristics to Fish Production

Limnological relationships existing in many of the high-quality recreation lake systems were examined. Lakes which were studied intensively were sampled every third week. Minor lakes were only sampled once or twice during an annual sampling period.

Sampling stations were established at approximately the deepest portion of each lake. Vertical profiles of temperature and specific conductance were recorded at each station. Water samples for comprehensive chemical analyses were collected and preserved at each station. Field chemical analyses, including alkalinity titrations, were conducted according to Standard Methods (1971). Comprehensive chemical determinations on preserved samples were conducted at a laboratory using atomic absorption and gas chromato-graphic analyses.

Bathymetric maps were prepared for each lake. A recording fathometer was used to record depth contours on transects crossing each lake. The depth contours were transferred to bathymetric maps and morphometric data were calculated from these maps.

Zooplankton were collected every 3 weeks by making duplicate vertical tows. The net used was 0.5 m diameter and 3 m long. The straining cloth had an aperture of 153 microns and 45% open area. Plankton were identified and counted. Dry and ash weights of plankton were determined gravimetrically.

The efficiency of the nets was not accounted for in the calculations. Thermal profiles and Secchi disc readings were taken in conjunction with plankton tows.

Stream drift organisms were collected by placing two nets in the main inlet. Nets used were 30.5 cm square, 91.4 cm long, made with Nitex with pore size of 280 microns and 45% open area. Benthos were preserved and later identified and enumerated in the laboratory.

Bottom fauna were collected by dredging with an Ekman 152.4-mm dredge. Bottom samples were washed through three screens, the finest having 28 meshes per inch. Organisms were preserved in 70% ethyl alcohol or frozen for laboratory analysis.

Adult and juvenile fish were collected by hook and line, gill nets, and fry traps. Age, growth, and food habits of fish in the lakes were determined from fish collected throughout the study period.

Evaluation of High-Quality Recreational Fishing Waters

The recreational potential of each of the lakes was evaluated. Information evaluated included present and future recreational opportunity and importance, proximity to other recreational areas, uniqueness of the area, ability of the system to support a viable fishery, accessibility, and aesthetics.

FINDINGS

A presentation of all data gathered during the course of this investigation would be too voluminous for this type of report. Instead of such a presentation, a summary from each annual investigation will be presented so those interested in more detail can find it in a logical manner. A brief comparison of productivity potential will then be made among southeast Alaska lakes and the productivity of southeast Alaska lakes will be compared to other north-temperate systems.

A more comprehensive analysis of these data is planned for publication in a major journal, i.e., Limnology and Oceanography.

Summary of Annual Investigations

Period Covered: July 1, 1974 through June 30, 1975 (Schmidt and Robards, 1975):

Although the project under contract code G-I-R had not been started during this period, these investigations led to the formation of G-I-R and data are used in comparisons of biological productivity.

Limnological investigations of eight lakes revealed; 1) all lakes studied have very limited production due to lack of nutrients and limited shoal areas, 2) conductivity of all lakes studied, except Redoubt, is less than 50 micromhos, and 3) Redoubt Lake is meromictic with an aerobic, saline, monomolimnion which acts as a nutrient trap. The standing crop of No. 20 net plankton was determined to compare trophic status of lakes. All lakes are oligotrophic. The descending order of productivity of these lakes according to this plankton index is as follows; 1) Swan, 2) Blue, 3) Osprey, 4) Auke, 5) De Boer, 6) Spurt, 7) Redoubt, and 8) Green. The bottom fauna of these lakes is dominated by Chironomidae and Oligochaeta. Fish growth appears to be correlated with the above factors, e.g., 1) growth of Dolly Varden is greater in Osprey than Spurt Lake and 2) rainbow trout populations are more successful in Swan Lake than in Spurt Lake or De Boer Lake.

Attempts to develop methods of indexing Dolly Varden and cutthroat populations in Auke Lake met with little success, as not enough fish were caught in any one type of gear. The Dolly Varden population in Osprey Lake was reliably estimated using large minnow traps.

A Ross 400A echosounder was used to demonstrate the distribution of fish in Auke and Swan Lakes. Rainbow trout were found to be concentrated near the inlets of Swan Lake.

Period Covered: July 1, 1975 to June 30, 1976 (Schmidt, 1976):

Limnological investigations and recreational analyses were conducted on the Naha Lakes and Roosevelt Lagoon in an attempt to: 1) determine the relationship of physical, chemical, and biological characteristics to fish production and 2) protect this high-quality fishing and recreational area from undesirable development.

Intensive limnological investigations were conducted on two of seven lakes throughout the summer. Other lakes were each studied for a 1-week period. Recreational analyses were conducted on all lakes.

Chemical and biological analyses indicate that lakes of the Naha drainage fall in the mid-range of productivity when compared to other southeast Alaska lakes. Plankton indices point out the high usage of the anadromous lakes by rearing salmon.

Recreational analyses of the Naha drainage show that it is unique. The drainage contains some of the finest sport fishing available in southeast Alaska. Included are; 1) high mountain lakes with reproducing Arctic grayling populations, 2) non-anadromous lakes with large cutthroat trout, 3) anadromous lakes with sockeye, coho, chum, and pink salmon, and 4) a large river with excellent runs of steelhead, sea-run cutthroat trout, and Dolly Varden.

Period Covered: July 1, 1976 to June 30, 1977 (Schmidt, 1977):

Limnological investigations and recreational analyses were conducted on the Sarkar Lakes in an attempt to; 1) determine the relationship of

physical, chemical, and biological characteristics to fish production and 2) protect this high-quality fishing and recreational area from undesirable development.

Intensive limnological investigations were conducted on two of five lakes throughout the summer. Other lakes were each studied for a 1-week period. Sarkar Lake was visited during two 1-week periods. Recreational analyses were conducted on all lakes.

Lakes of the Sarkar system are quite shallow. None has a mean depth greater than 11 m. A comparison of productivity potential by the morphoedaphic index shows Tammy and Finger Lakes as the most productive studied in southeast Alaska to date. Plankton indices show the Sarkar Lakes to be quite productive when compared with other southeast Alaska systems. The presence of Chaoborus sp. larvae in plankton samples throughout the summer may indicate a paucity of rearing sockeye salmon.

The Sarkar system contains coho, chum, pink, and sockeye salmon, steelhead, resident and sea-run cutthroat trout, and Dolly Varden. The lakes are especially suited to cutthroat trout.

Recreational analyses indicate that the system should be developed into two areas. The easy access area, Sarkar Lake, should have facilities, including a boat ramp, picnic area, trails, and possibly a bear observatory. The limited access area would be a canoe route through Finger, Raven, and Long Lakes. The highlight of the Sarkar system is the abundance and diversity of its mammalian and avian fauna.

Period Covered: July 1, 1977 to June 30, 1978 (Schmidt, 1978):

Limnological investigations and recreational analyses were conducted on Ella, Manzanita, Turner, and Wilson Lakes and Duncan Creek in an attempt to determine the relationship of physical, chemical, and biological characteristics to fish production and to protect high-quality fishing and recreational areas from undesirable development.

Intensive limnological and fishery investigations were conducted on the four lakes throughout the summer. Duncan Creek and saltchuck was investigated during two 1-week periods. Recreational analyses were conducted on all systems.

Ella, Manzanita, Turner, and Wilson Lakes are large (624-1,270 ha) oligotrophic lakes. Mean depth ranges from 30.3 m (Turner Lake) to 70.2 m (Wilson Lake). Chemical analyses indicate that Ella, Manzanita, and Wilson Lakes have the highest conductivity (47-68 micromhos) of lakes analyzed to date in southeast Alaska.

All lakes have cutthroat trout and kokanee populations and are popular high-quality recreational fishing areas.

Cutthroat trout from Wilson Lake had the slowest growth rate but the greatest weight at any given length of all lakes studied. Condition factors of cutthroat trout from Wilson Lake averaged 1.05, the highest

of all lakes studied. Cutthroat trout from Manzanita Lake were longer at any given age but had the lowest weight at any given length. Condition factor of cutthroat trout from Manzanita Lake was 0.88, much lower than Wilson Lake at 1.05 or Turner Lake at 1.02. Cutthroat trout from Manzanita Lake appear to have characteristics of both cutthroat and rainbow trout. The condition factor of cutthroat trout from Ella Lake was the lowest at 0.84.

Condition factors of Dolly Varden were the lowest in Wilson Lake (0.85) and highest in Ella Lake (1.35), just the opposite from the trend in cutthroat trout.

Stomach content analysis of cutthroat trout showed that they fed heavily upon kokanee once they obtained a size of about 240 mm. The second most important food source was Chironomidae adults and pupae.

Analyses of kokanee stomachs showed that kokanee fed primarily on insect larvae and pupae and recently emerged adults. Fish were commonly seen schooled off inlet deltas where they were gathering stream drift organisms. Only 2 of 34 fish examined had fed on Cladocera.

Investigation of Duncan Creek and Saltchuck showed this system to be a very important area for coho salmon and cutthroat and rainbow trout. Coho salmon and rainbow trout were found throughout the entire stream system surveyed. The rearing rainbow trout are thought to be steelhead trout presmolt, but the presence of adult steelhead trout has not been confirmed. Rearing coho salmon were abundant in the saltchuck. Adult cutthroat trout and Dolly Varden were abundant in the lower section of Duncan Creek. Schools of cutthroat trout were seen feeding in the saltchuck rapids area.

Period Covered: July 1, 1978 to June 30, 1979 (Schmidt, 1979):

Limnological investigations and recreational analyses were conducted on seven lakes in an attempt to further quantify the relationship of physical, chemical, and biological characteristics to fish production. Intensive limnological and fishery investigations were conducted on four lakes (Gar, Red, Rezanof, and Salmon Bay), while the other three lakes (Big Bay, Kvoustof, and Lower Kvoustof) were only sampled once during the summer. Recreational analyses were conducted on all systems.

Analysis of physical and chemical parameters indicate Red Lake has the highest potential fish yield, 2.41 kg per ha, of lakes studied to date in southeast Alaska. Salmon Bay Lake was considerably lower, 0.86 kg per ha, and Lonieof and Rezanof are the lowest studied to date, 0.25 and 0.17, respectively. Specific conductance was high in Red Lake (93 micromhos) and very low in Lonieof (5 micromhos) and Rezanof (3 micromhos).

Red Lake and Salmon Bay Lake are anadromous and both have fish populations of rainbow/steelhead and cutthroat trout, Dolly Varden, and coho and sockeye salmon. Condition factors of resident cutthroat trout

from Red Lake and Salmon Bay Lake were 1.00 and 0.98, respectively. Cutthroat trout from Big Bay Lake, a non-anadromous, muskeg lake, had a mean condition factor of 0.85.

Rezanof, Kvoustof, and Lonieof Lakes are a chain of non-anadromous lakes which have rainbow trout as the only fish species. Mean condition factors of rainbow trout were nearly the same from Rezanof Lake (1.06) and Lonieof Lake (1.08). Condition factor of rainbow trout from Kvoustof Lake was 1.22.

Cutthroat trout stomach analyses from Red Lake and Salmon Bay Lake showed a high dependence of cutthroat trout on salmon fry, threespine stickleback, and beetles. Food of the cutthroat trout from Big Bay Lake, a landlocked system, was primarily midges.

The diversity of food organisms found in rainbow trout stomachs indicate they are eating whatever is available. The most frequently eaten items were mayflies, caddis flies, midges, and black flies. Zooplankton apparently was little utilized.

Period Covered: July 1, 1979 to June 30, 1980:

Program was inactive during this period.

Period Covered: July 1, 1980 to June 30, 1981 (Schmidt, 1981):

Limnological relationships existing in ten lakes were investigated. Two of the lakes (Mountain and Situk) were sampled intensively every third week. Akwe Lake was sampled twice. All other lakes were visited only once during the summer. Recreational analyses were conducted on all systems.

Analyses of physical and chemical parameters indicates that Mountain and Situk Lakes are the second and third most productive of lakes studied to date in southeast Alaska. Morphoedaphic index of these lakes is 2.88 and 2.20, respectively. Akwe Lake had a morphoedaphic index of 0.56. Specific conductance of Situk Lake (105 micromhos) and Mountain Lake (100 micromhos) are the highest encountered to date in southeast Alaska lakes. Akwe, a glacial lake with specific conductance of 48, had unusually high iron content (632 micrograms per liter).

The Situk system is, in terms of fish, the most productive of its size in southeast Alaska. This is one of the most popular sport fishing systems in the state.

Period Covered: July 1, 1981 to June 30, 1982 (Schmidt, 1982):

Limnological investigations were conducted on three popular recreational-use lakes; Avoss, Baranof, and Sitkoh. These lakes were sampled intensively every fourth week from May 1 through September 1, 1981.

Population estimates of resident salmonids were attempted and recreational analyses were conducted for all three lakes.

Period Covered: July 1, 1982 to June 30, 1983 (Schmidt, 1983):

Limnological investigations were conducted on Davidof, Plotnikof, and Salmon Lakes and Plotnikof River.

Population estimates of resident salmonids were attempted and recreational analyses were conducted for all three lakes. Recommendations for further study was made on one lake and one river system.

Productivity Potential of Southeast Alaska Lakes:

The morphoedaphic index (MEI) (Ryder, 1964; 1965) is an emperically-derived formula that was described initially as a convenient method of rapidly calculating potential fish yields from unexploited North-temperate lakes. Since its inception, the constraints on the use of the MEI have been relaxed, as it has been applied to sets of lakes other than those for which it was originally devised. Various investigators have clarified our understanding of the MEI, e.g., Jenkins (1967), Regier et al. (1971), and Henderson et al. (1973), and have extended the application of this index to other climatic systems.

A review and evaluation of MEI and its usefulness as a yield estimator is given by Ryder (1974). The MEI is probably the most easily determined index for establishing a ranking of productivity.

The range of MEI index numbers on a global scale ranges from near zero to in excess of 300,000. The optimum MEI is about 40. Yields decrease as numbers increase or decrease from 40. A MEI near zero denotes unproductive water due to lack of total dissolved solids and nutrients, while a MEI over 100 begins to place osmotic stress on many freshwater fish species. Jenkins (1970) showed that maximum crops of reservoir fishes were from reservoirs with indices of between 16 and 100.

The MEI and the associated potential fish yield in kg/ha for 36 lakes studied throughout southeast Alaska are presented in Table 2.

The two highest ranked lakes, Helen and Red, have an artificially elevated MEI due to presence of saltwater influence. The most productive lakes studied to date are Mountain and Situk Lakes, which are near Yakutat. These lakes have a relatively high conductivity and moderate average depth, placing them high on the scale.

All other lakes studied have a MEI of less than 2.0.

All of our best cutthroat lakes have a MEI of 1.0 or less. These include Turner, 0.33; Baranof, 0.43; Wilson, 0.67; Mazanita, 0.86; and Virginia, 1.00.

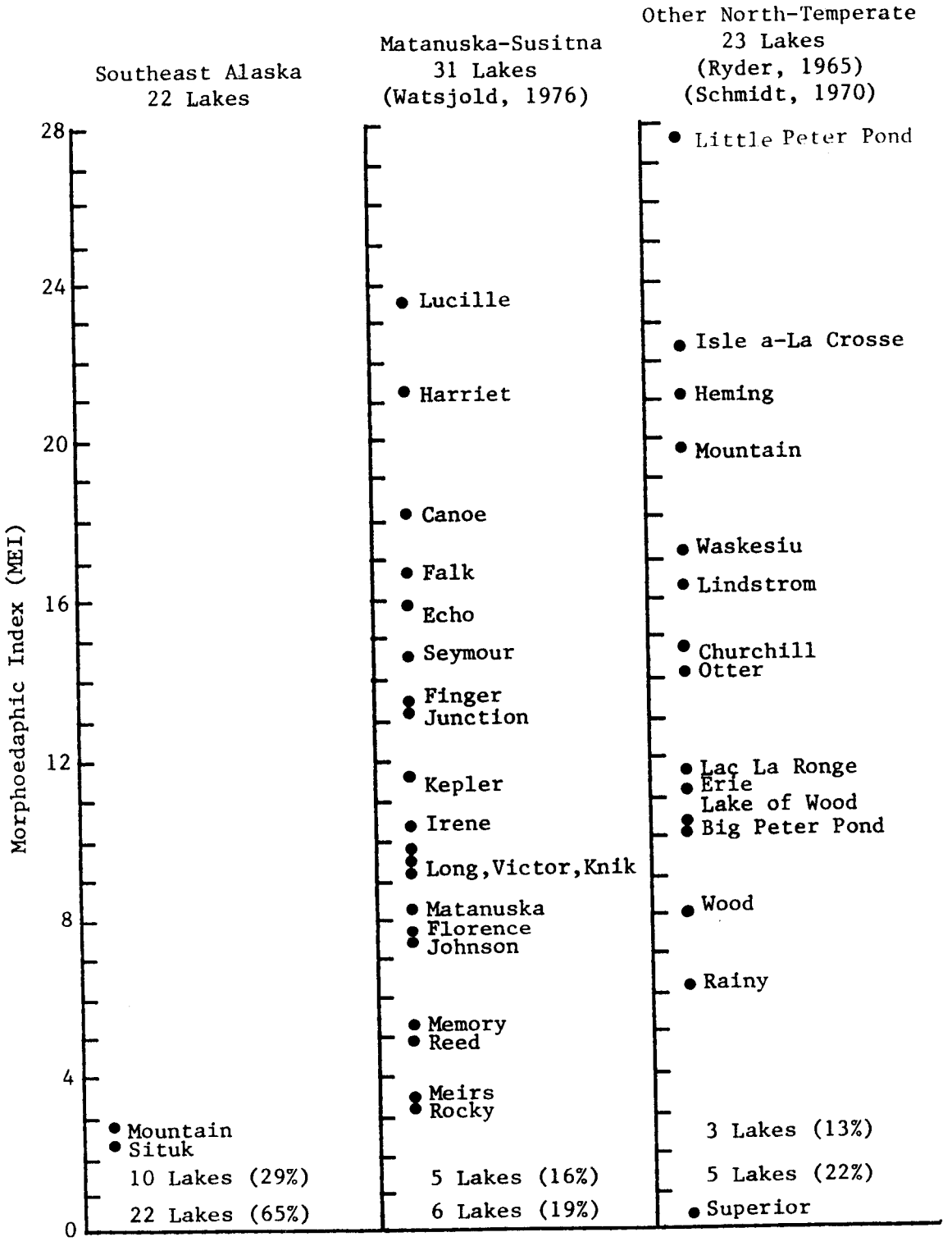

Figure 2. Morphoedaphic Index of Southeast Alaska Lakes Compared With Matanuska-Susitna and Other North-Temperate Lakes.

Table 2. Morphedaphic Index of 36 Lakes in Southeast Alaska.

Lake	Specific Conductance (u mhos)	Residue Dissolved Calculated Sum (mg/l)	Surface Area (ha)	$\bar{z}$ Depth (m)	MEI*	Potential Yield** (kg/ha)
Helen	50	35***	14.5	3.7	9.46	2.97
Red	93	65***	166.0	10.4	6.25	2.41
Mountain	100	59	83.0	20.5	2.88	1.64
Situk	105	60	408.0	27.3	2.20	1.43
Streets	30	21	60.7	11.0	1.91	1.34
Finger	28	20***	347.0	10.7	1.87	1.32
Tammy	25	18***	134.0	10.0	1.80	1.30
Green	39	22	70.0	12.3	1.79	1.29
Salmon	26	18	41.1	10.4	1.75	1.28
Bear	29	21***	30.7	12.2	1.66	1.24
Klawak	39	24	1,177.0	17.7	1.36	1.13
Hofstad	17	12***	60.3	9.8	1.22	1.07
Auke	28	20	46.0	19.0	1.05	0.99
Virginia	18	13***	258.0	13.0	1.00	0.97
Manzanita	60	42***	625.0	49.0	0.86	0.89
Salmon Bay	30	21***	388.0	26.7	0.79	0.86
Sitkoh	39	27***	209.5	35.2	0.77	0.85
Heckman	17	14	163.0	19.7	0.71	0.81
Spurt	16	14	107.0	22.2	0.63	0.77
Karta	26	16	508.0	27.6	0.58	0.74
Bugge	20	14***	66.8	24.0	0.58	0.74
Akwe	48	28	216.0	50.1	0.56	0.72
De Boer	13	13	51.0	23.0	0.56	0.72
Wilson	51	36***	468.0	54.0	0.67	0.69
Ella	47	33***	710.0	70.0	0.47	0.66
Patching	17	14	207.0	30.2	0.46	0.66
Blue	33	22	538.0	52.0	0.42	0.63
Turner	15	10***	1,270.0	30.0	0.33	0.55
Osprey	20	14	109.0	60.0	0.23	0.46
Baranof	22	8***	323.6	39.0	0.20	0.43
Swan	20	16	208.0	91.4	0.18	0.41
Avoss	21	8***	123.7	45.8	0.18	0.41
Plotnikof	14	10	320.4	37.4	0.27	0.50
Davidof	12	8	140.8	52.5	0.15	0.38
Lonieof	5	4***	179.0	55.1	0.07	0.25
Rezanof	3	2***	354.0	71.2	0.03	0.17

*MEI = Morphoedaphic Index = $\frac{\text{Total Dissolved Solids (TDS)}}{\text{Mean Depth } (\bar{z})}$ (Ryder, 1965)

**Ryder (1965) described the equation $y \sim 2\sqrt{x}$ where y = yield in pounds per acre and mean depth ($\bar{z}$) was in feet. The metric expression (Ryder et al., 1974) is therefore $y \sim 0.966\sqrt{x}$ where yield is fish yield as kg/ha and x = MEI.

***Calculated as 0.70 x specific conductance in micromhos.

The better known rainbow trout lakes on Baranof Island have the lowest MEI: Rezanof, 0.03; Lonieof, 0.07; Davidof, 0.15; Plotnikof, 0.27; and Avoss, 0.18.

Figure 2 compares southeast Alaska lakes with Matanuska-Susitna Lakes and other lakes in the North-temperate area.

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